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Toward a data-driven estimate of ENSO-induced anomalies in biospheric NEP

C. Schwalm (1), C. Williams (2), I. Baker (3), and J. Collatz (4)

(1) Graduate School of Geography, Clark University, Worcester, MA, USA, cschwalm@clarku.edu, 508-793-8881, (2) Graduate School of Geography, Clark University, Worcester, MA, USA, cwilliams@clarku.edu, 508-793-8881, (3) Atmospheric Science Department, Colorado State University, Fort Collins, CO , USA, baker@atmos.colostate.edu, 970-491-8449, (4) Goddard Space Flight Center, NASA, Greenbelt, MD, USA, Jim.Collatz@nasa.gov, 301-614-6695

Analysis of the effects of El Niño-Southern Oscillation (ENSO) events on global carbon cycling currently relies heavily on modelling paradigms. With the advent, since the early 1990s, of FLUXNET, a global network that directly measures net ecosystem productivity (NEP), observational data are now available to provide data-driven estimates of global carbon fluxes and their response to weather and climate extremes. This work combines FLUXNET data with reanalysis and remotely-sensed products to develop a novel data-driven approach to estimate the global flux anomaly in NEP induced by an ENSO event of arbitrary magnitude. NEP data from FLUXNET sites were initially analyzed relative to a drought index (evaporative fraction; the ratio of latent heat to available energy) to calculate the sensitivity (the change in flux expressed in monthly mass density by biome and climatic season) of NEP to drought. These sensitivities were then combined with a 1° grid of the IGBP biome classification, derived from AVHRR 1km imagery. This resulted in a global mask of drought sensitivities for every 1° cell. In order to quantify the global NEP anomaly NCEP/DOE AMIP-II 1° reanalysis data was used to calculate evaporative fraction, i.e., ENSO response = drought sensitivity x evaporative fraction. ENSO events were defined using the MEI (multivariate ENSO index). We focused on the satellite era, from 1983 – present, to allow a comparison with model-derived results that require remotely-sensed input data, i.e., Simple Biosphere Model, Version 3 (SiB3). This approach allowed for the calculation and intercomparison of 6 ENSO anomalies corresponding to the following ENSO events: 1991-1992, 1993, 1994, 1997-1998, 2002-2003, 2004-2005. Overall, ENSO anomalies were highly variable, even after normalization for magnitude and duration. Spatially, ENSO events were characterized by distinct regions with diverging patterns in anomaly direction. Similarly, globally integrated NEP anomalies exhibited both positive and negative trends when comparing across ENSO events. In general ENSO anomalies in the southern hemisphere (SH) were smaller than in the northern hemisphere (NH). Warm season response was also larger than in the cold season, i.e., winter, irrespective of biome. Inconsistencies between model-based versus data-driven estimates will be discussed, as will implications for diagnosing NEP versus fire contributions to ENSO-induced anomalies in global atmospheric carbon dioxide.